Trombiculid Mites infesting Bats in Malaya, with Descriptions of Three New Species

By J. R. AUDY, M.B., B.S., Ph.D.

Three new larval trombiculid mites (chiggers) infesting bats in Malaya are here described. This opportunity is taken to give additional notes on those species so far described from bats and collected by the Colonial Office (Scrub Typhus) Research Unit at the Institute for Medical Research, Kuala Lumpur.

Bat-chiggers are of particular interest for several reasons. Firstly, the genotype *Trombicula minor* Berlese 1903 was described from two adults from bat-guano in a cave at Tjornea, Java. The larvae are presumed to have been infesting the bats but this is admittedly conjectural. The description is imperfect and the type specimens were destroyed during the recent war. Every effort should be made to breed out bat-chiggers in the hopes of rediscovering *T. minor*; as Philip and Traub (1950) have suggested, their species *T. batui* from Malaya might be very close to or even the same as *T. minor*. Secondly, though there are more species of bats than of any other order of mammals in Malaysia, only 8 out of a total of 84 Malaysian chiggers have so far been described from bats, so that there is presumably a large unexplored field here. Thirdly, though most chiggers attack several or many different hosts, some bat chiggers appear to be more host-specific, or it may be habitat-specific, and a study of them as a group may throw light on unsuspected relationships, both of the bats and of the chiggers. In any case, the parasite-patterns may give sadly-needed information on the ecology of different groups of bats, using the parasites as ‘ecological labels’ (Audy 1947; Inst. Med. Res., 1952).

There are interesting records of the recovery from bats of chiggers very closely related to *T. akamushi*, the vector of scrub typhus. These records, of great zoogeographical interest, are as follows: *T. myeti* Ewing from *Myotis* (and ? other bats) in North America, and *T. russiev* (Oudemans) from a bat in Europe, are almost indistinguishable (Wharton 1947; Fuller 1948) from *T. akamushi* itself, which is a very common species in grassland from Japan to Malaysia. Though *T. akamushi* itself has not been recorded from bats, its very close relative, *T. delicassia*, also a vector of scrub typhus, was found by us infesting a
tomb-bat from a rock-cave on a tiny island off the coast of Malaya (see below). Another species, *T. natalensis* Lawrence 1949, from a South African horseshoe bat (*Rhinolophus geoffroyi*), appears to be very close indeed to *T. okamushi* and it is understood that Dr. R. F. Lawrence is comparing his species with material from Malaya.

The following species, some of which are described more fully in this paper, have been recorded from bats in the Oriental and Australasian regions: *T. schmitzi* from India; *T. batavi* from Malaya, which may be very near to or identical with *T. minor* from Java; *T. insolii* Philip and Traub from Malaya, related to *T. piercei* Ewing from a bat in the Philippines; *T. leveri* Womersley, 1952, from Malaya and Fiji; *T. harrisi*, the commonest bat-chigger in Malaya; *T. tapozena* Wom. from Malaya, related to *T. philipi* Wom. from a bat in New Guinea; *T. quadriseptifer* Wom. (= *T. chiroptera* Wom.) from bats, rats, and marsupials in Australia; *Myotrombicula vespertilionis* Wom. from Australia; and *Euschongastia lipocosa* (Wom. 1952)* from Malaya. To these we can now add a detailed record of *T. deliensis* and two new species of *Trombicula* and one of *Schongastia*, together with a reference to a new species of *Hannemania* which has been described by Womersley (in MS).†

*Trombicula deliensis* Waleh, 1922

A single specimen of *T. deliensis* was found attached to one (R. 9632) of 38 tomb-bats, *Taphozous melanopogon*, collected from a rock-cave in a tiny islet, Pulau Seletan, adjacent to Pulau Angsa (pulau = island), 6 miles from the coast of Selangor above Port Swettenham, on 1st February, 1950 (Rep. Inst. Med. Res., Malaya for 1950, 1951, p. 40). Mr. J. Wyatt-Smith, who accompanied the original collecting party, paid a second visit to this

*Womersley* (1952) recognises only the two genera *Neoschongastia* n.s. and *Schongastia* n.s., the latter including only two Old World subgenera, subgenus *Schongastia* n.s. and subgenus *Aeomeschongastia* n.s. This view is at present unfavourable and has not had an opportunity to gain acceptance. In the present paper, therefore, the genera *Schongastia* and *Aeomeschongastia* are both regarded in the restricted sense, and *Euschongastia* as a genus in the broad sense, following Wharton et al. (1941).

† Since this paper went to press, two additional new species have been recovered from *Hyposcodon* spp.: one a *Hannemania*, the other a *Trombicula* near *T. harrisi*. A batch of 18 hairless buldog bats, *Cheirodendron turquesteanum*, obtained from a colony in a hollow tree, were found to be free of chiggers (but infested by *Arixenella tosuni*, *Dermaptera*); a nineteenth bat had been kept by the Sleekis as a pet in their huts for three or four days, and this was found to have 7 chiggers attached to it, viz. 2 *T. deliensis* and 5 *T. musaridae* Wom., both of which were bred to nymphs. The *T. deliensis* at least, and probably also the others, were doubtless picked up during captivity.

Mus. 24, 1952.
cave on 15th May, 1951, when he found there were relatively very few bats present. He collected one specimen, also of T. melanopogon, infested by three species of Trombicula (taphozous, insollii, batui).

**Trombicula (Trombicula) batui Philip & Traub, 1950**

Described from 5 specimens from a cave fruit-bat, Eonycteris spelaea, from Batu Caves (limestone) near Kuala Lumpur. A single specimen was found later on a tomb-bat, Taphozous melanopogon, from Seletan island off the Selangor coast. The following notes may be added to the published description.

Except for the scutal and dorsal setae, there is a general tendency towards either nudity of setae or for the presence of a few long barbs. **Legs:**—Leg I: subterminala fairly short, with 2 nude (?few inconspicuous barbules) setae near base of pretarsus; spur short (15 μ), microspur posterior and distal at about half length of spur; 3 tibialae, posterior ones in tandem, microtibialae at distal end of joint; 3 genuae, two dorsal in tandem, one posterior; tapering seta with few barbules on femur. Leg II: spur 19 μ, longer than spur I, microspur anterior and distal to its base; 2 slender tibialae in tandem; 1 genuula. Leg III with tapering nude setae, apparently not striated or refractile, often outstanding: 1 on tarsus (ca. 2/3 length of tarsus); 2 in tandem on tibia, distal one longer; 2 on genu, anterior one longer; 2, anterior and dorsal, about as long as genu, on basifemur, and an almost nude ventral seta; 1, dorsal, on basifemur. **Scutum:** in this specimen, the ‘shoulders’ of the anterior margin are much more prominent and convex than in the authors’ drawing from the Batu Caves specimens. Standard measurements (slide No. 24, 972): AW 43, PW 50, SB 29, ASB 26, PSB 21, AP 27.5, AM 29.5, AL 27, PL 37.5, Sensilla missing. **Body setae:** DS in rows 2.8.8.5.6.4.2 = 36 DS (29 μ, humerals 44-5 μ) + 14 caudal setae, CS + 17 VS (22 μ).

**Trombicula insollii** Philip & Traub, 1950. Fig. 4

Described from 3 larvae from *Eonycteris*, taken with *batui*. A further 30 larvae have since been taken, from two tomb-bats from Seletan island off the Selangor coast, on 1st February, 1950 and 16th May, 1951. The following notes are added from a study of these specimens.

**Legs:**—Ordinary leg setae fairly large with many long barbs (pectinate). Leg I: subterminala fairly short (about half length of spur) with parasubterminala about half its length; spur long (32 μ), more pointed at tip than spur II, microspur.
TROMBICULID MITES FROM MALAYAN BATS

distally at about half length of spur, distinctly curved; 2 tibialae, long microtibiala; 2 genualae, posteroventral one slender, dorsal one fairly short, very fine and tapering, with long microgenualae distally in tandem. Leg II: spur slender but blunt-tipped, microspur proximal to its base; 2 pointed tibialae in tandem; pointed genualae. Leg III: tapering tibiala, about half length of tibia; 2 long slender genualae, little longer than genu; 1 long slender femorala. Scutum in some specimens extended out to PL bases as a tongue. Standard Measurements of 6 specimens are shown in Table 1. Body setae: DS in rows 2.8.8.8.6.6.4.4.2 = ca. 48 DS (50μ, humeral setae 51μ) + 30-34 caudal setae (CS) + 16-18 VS with fewer slender barbs.

### TABLE 1

**Standard Measurements of 6 Specimens of Trombicula insollii**

*Philip & Trabk, 1956, from a Tomb-Bat, Selatan island, off Selangor coast*

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Trombicula (Neotrombicula) harrisoni Womersley, 1952. Fig. 2

Described from 10 larvae from *Hipposideros* sp. This is the commonest bat-chigger encountered so far, about one in ten specimens of *Hipposideros* being infested, often with 10-25 chiggers. The nymph has also been described, from a specimen bred out and correlated with the larva by Mr. M. Nadehatram of the Scrub Typhus Research Unit. To Womersley's description of the larva we can add the following notes.

Colour pinkish. **Legs:**—Leg 1 with long spur, distinctive microspur distally (2/3rd along length of spur), with a stout base and curved (talon-like) 2 tibialae, anterior blunt and fairly thick, posterior pointed, microtibiala distal to their bases; 2 genualae in tandem plus 1 posteriorly, tapering, and a microgenualae distally; seta with few barbs on femur, may be outstanding. Leg II: spur short (1/3 length of spur I), microspur
proximal and close to base; anterior tibiala blunt-tipped and as long as tibia, posterior and more proximal tibiala shorter, tapering; genuala as long as genu. Leg III: tapering tibiala reaching to tarsus; long genuala, nearly as long as tibiala and longer than genu. Coxal seta II shorter and more closely barbed than the others which tend also to be pectinate, with long barbs. Palpal setae: on femur and genu stout with many barbs; on tibia, dorsal seta strong with conspicuous barbs, lateral seta generally forked, ventral branched. Scutum drawn for comparison with the following species at fig. 2. Scutal setae slender and tapering. Body setae: Dorsally in rows e.g. 2.6.5.6.2(4).2(4) = 28–32 DS (38μ, humeral setae 43μ) + 16–24 CS + ca. 16 VS (22μ) with fewer barbs.

**Trombicula (? Neotrombicula) dimolinae** sp. nov. Fig. 1, 2

A species distinguished from the related *T. harrisoni* by the sinuous anterior and posterior, and concave lateral, margins of the scutum and a very distinctive sensilla, and by the presence of a third pair of sternal setae.

**Description of Larva.**—Body oval; partly engorged larva 400μ × 200μ. Colour yellowish. Eyes 2 + 2, indistinct, well to the side, fairly large, posterior eye the smaller. Body striae faint. Gnathosoma: Cheliceral bases rounded, with few inconspicuous punctae; blade short (30μ), very deep (14μ), and broad at base, rapidly narrowing down to the small dorsally pointing tricuspid cap; paired pseudocheilus 8μ long prominent in one specimen. Galeal seta nude. Palp: fairly slender with rounded tubercle at angle of femur; setae on femur and genu long, stout, with long lateral barbs; on tibia, dorsal seta long nude, others with several fairly long barbs; tarsus with a thick apical seta with terminal barbs or branches, sensory red, and 4 barbed setae, one of which appears almost in some specimens. Claw 3-pronged, axial (25μ) slightly curved, two subequal accessory prongs. Legs: all 7-jointed slender with elongate joints, I–III 230μ, 185μ, and 210μ long. Sensory setae tend to be fairly long and tapering. Leg I: spur (tarsala or sensory red) long with small microspur distally; 2 tibialae, distal one longer and tapering with microtibiala near base; 3 genuala (one being posterior), microgenuala. Leg II: fairly long spur, microspur proximally; 2 tibialae in tandem, distal tibiala longer and stout and about the same length as the tibia; slender tapering genuala. Leg III: unusually long, tapering, curved tibiala and genuala, the latter about the same length as the tibia and the tibiala a little shorter than this—these two setae are striated and

[138] BULL. RAFFLES
Fig. 1. Trombicula dimolinae sp.n., including palp and chelicer (lateral view).

Mus. 24, 1962.
Fig. 2. Scuta (and eyes) of bat-chiggers: TD—T. exsulcata atollinae sp.n. TH—T. harrisoni Womerley, 1952. TT—T. taphozonis, Womerley, 1952, toptotype No. 24793.
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clearly show the hollow central appearance of the typical short sensory setae and so they differ in character from the usual whiplike and outstanding and nude setae. Though they tend to curl, these setae may however give the appearance of a mastitibia and a mastigenual. Scutum (fig. 2): trapezoidal, anterior and posterior margins sinuate, punctae coarse but not conspicuous. The scutum appears to be poorly chitinised and there is a tendency for striae to appear as artefacts; further, there is a tendency for the lateral and postercutaneous margins to be submerged in the cuticle. In several specimens (fresh mounts) the PL setae thus appear to be cut off from the scutum and if these were to be examined alone there would be great difficulty in not deciding that the PLs were separated from the scutum, which would place the specimens in the subgenus *Tecomathana* (= *Tricentus?*). It will thus be necessary to bear this possibility in mind when distinguishing this subgenus on scanty or defective material. Scutal setae with short barbs; AL setae obviously the shortest. Interval between SBs less than twice their diameter. Only one specimen (holotype) had a single sensilla, and this was very distinctive, thickened in the middle of the shaft and tapering at each end, bifurcate with a few long barbs on the smaller branch, the main shaft conspicuously spinate near the base (cf. *pulida* Nagayo et al.) and then bearing a number of lateral barbs up to 15, long, several of which are bifurcate. The Standard Data of the scutum are shown in Table 2. *Body setae*: DS

**Table 2**

**Standard Measurements of Holotype and 11 Paratypes of *Trombicula dimolinae* ssp.n.**

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Means: 44.9 64.4 18.4 24.5 16.4 33.9 47.4 32.6 56.8 68

Mus. 24, 1962. [139]
fairly slender, similar to PL scutal setae, with short barbs, arranged in rows but with irregular setae medially and laterally in the first row and laterally in other rows, e.g. 2.4.10.4.12.6.6.4, totalling 44–60 DS (12 to 32 μ); humeral setae 45 μ + caudal setae (CS) in rows on level of and behind anus, 14–15 CS (total setae of dorsal type 64–74) + 22–25 VS (27 μ) more slender, with two or three lateral barbs and a free pointed tip, arranged roughly in rows and more or less distinct from the caudal setae. One pair of sternal setae between coxae I and two pairs of sternal setae between coxae III.

_Type Material._—Holotype (No. 24,007) and 11 paratypes from the ears of a horseshoe bat (R. 17,041) Rhinolophus sp., from Bukit Lagong Forest Reserve, Kepong, Selangor, on 25th January, 1952. Holotype and paratypes to be deposited in the British Museum (Natural History), paratypes in the Raffles Museum, South Australian Museum, and U.S. National Museum.

_Remarks._—These larvae all appeared dead and shrivelled and no attempt was made to breed them. They were all attached to the inner face of the edge of one ear of the bat. The peculiar sensilla recalls the medially thickened sensilla of _T. harrisoni_, which is distinguished from _dimolinace_ as shown in the Key. Because of the general relationship of _dimolinace_ to _harrisoni_ in larval characters and association with bats, this species probably belongs to the subgenus _Neotrombicula_, in which _harrisoni_ has been placed on nymphal characters.

This species has been named for Miss Susan Dimoline, who was a voluntary helper in the Scrub Typhus Research Unit for a year from September 1948. Without her very welcome assistance in examining thousands of slides the routine identification of mites could not have been brought up to date in such good time.

_Trombicula revelae_ sp. nov. Fig. 3, 4

A species with a broadly trapezoidal scutum with a sinuous posterior margin, sensillary bases near the line of PLs.

_Description of Larva._—Body broad oval; partly engorged larvae 339 μ × 300 μ. Colour pink. Eyes 2 + 2, indistinct, on tucular plate level with PL bases. Cuticular striae distinct. Gnathosome: Cheliceral base with few punctae; blade 23 μ, dorsally curved to a small tricuspid cup. Cephal seta nude. Palp: small tuberole at angle of femur; palpal setae nude and long (on genu, 31 μ), tarsus with stout apical brush-like seta, fairly long spur, and 6 setae, mostly barbed but two with one or two barbules only. Claw 2-pronged, slender with smaller outer prong. Legs: all
Fig. 3. *Trombicula revelae* sp.n., including palp.

7-jointed, joints relatively slender. Leg I: spur long (22 µ), microspur curved, distal to base of spur and near its tip; 2 tibialae in distal half of tibia, posterior proximal one pointed, anterior and distal one with blunt tip and a long microtibiala (nearly 1/3 of tibiala) behind its base; 2 genualae, posterior one more slender, long microgenula anteriorly. Leg II: spur fairly long, microspur antero-proximal and close to its base (proximal, in tandem, on one leg of one specimen); 2 tibialae in tandem, distal one relatively blunt; 1 genuula. Leg III: slender tibiala; 2 slender long genualae not in tandem (about as long as genu); long (25 µ) tapering curved telofemorala (cf. masti-femorala).
about as long as tibia; all these setae refractive. *Seutum* (fig. 4): roughly rectangular, the anterior corners rounded off in front of the AL bases, anterior margin slightly sinuous; AL and AM bases in line; unusually large area behind AM base free of punctae. Seutal setae slender with short barbs or stipules, PLs distinctly long (56). Sensillary bases well separated, very near posterior margin producing a slight sinuosity. Sensillae normal, with ca. 10 fairly long barbs on distal half. The Standard Measurements are shown in Table 3. Body setae: DS slender with small barbs or stipules, similar to PLs, in irregular rows (cf. those of *diminutae*), e.g. 2:12:4:10:10:8 + 8 = 46-52 DS (40, humeral setae 42, + caudal setae becoming confused with VS in the long para- and anal row, total 26-34 CS (total setae of dorsal type, 72-86) + 10-16 VS (29), with fewer and longer barbs, arranged roughly in rows but irregularly. In two specimens, a ventral seta was double, two setae arising from the same base. This appears to occur more frequently with chiggers which have irregular and asymmetrical body setae.

*Type Material.*—Holotype (No. 24, 251) and 3 paratypes from R. 17,108, and 3 paratypes from 3 other horseshoe bats (R. 17,107, -9, -10), *Hipposideros* sp., from a cave in a limestone hill, at about 5° 27' N., 100° 17' E., near Kangar, Perlis, collected on 4th February, 1952 by staff of the Selangor Museum.

### TABLE 3

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[142] Bull. Raffles
Fig. 4. Scuta (and eyes) of bat-chiggers: TR—*Trombicula revolae* sp.n. TI—*T. insulsi* Philip & Traub, 1950, from a tomb-bat, Selestan Island; EL—*E. echinopteris lipozenta* (Womersley, 1952), of which no specimen with sensilla was available for drawing; the sensilla has been drawn from the description and figure given by Womersley (1952) ("broadly lanceolate, strongly setulose, without a distinct basal stem") mean length 61.4 μ with head 8.4 wide.
Trombicula taphozous Womersley 1952. Fig. 2

Described from a single specimen from a tomb-bat, *Taphozous melanopogon*, from the cave on Seletan island on 1st February, 1950. We have since seen 8 specimens of this species, collected by Mr. Wyatt-Smith from the same cave and host on 15th May, 1951. The following data can be added to Womersley's description.

Colour orange or pink. Eyes 2, the posterior one distinctly smaller. Galeal setae nude. Palpal setae: on femur long with short serrated barbs or ciliations; on genu fairly long, nude or with a few barbs; on the tibia, dorsal seta nude or with a single barb, lateral nude, ventral with long branches. Claw 3-pronged, the ventrolateral accessory prong being inconspicuous in some specimens. Chelicerae dorsally curved at tip to a small tricuspid cap. Legs 7-jointed. Leg I: the spur is long (25µ) and fairly slender, with long microspur distally; 2 tibialae, the posterior one more slender and tapering, microtibiala long (6µ); 2 dorsal and 1 posterior pointed genua, long microgenuala. Leg II: long spur, long microspur proximally; 2 tibialae not in tandem, distal one one stouter and blunt; 1 genua. Leg III: a slender tapering seta on the tarsus and on the tibia carries only a few small barbs and may appear nude; slender pointed tibiala; fairly long slender pointed genua, at least as long as the genu. Scutum drawn to the same scale as others, at fig. 2. There are two small plates near the anterior margin of the scutum which can be seen only with difficulty in some fresh mounts. The Standard Data of eight larvae (topotypes) from one collection are shown in Table 4. Body Setae: dorsal setae blunt-tipped with inconspicuous barbules, irregularly arranged roughly in rows with many setae caudally, difficult to count, first row 14-18; e.g. 2.14.15.12.10.12 + 18 = ca. 80-90 DS (34µ) + ca. 20-28 CS + ca. 30-36 VS (27µ) also irregularly arranged and sharp-pointed with longer barbs. Total body setae about 140.

Remarks.—The peculiar plates on the scutum are indistinct in several of the larvae from Seletan island, but in a recent collection of 14 horseshoe bats (*Hipposideros* sp.) from a limestone cave in north Malaya (near Kangar, Perlis) there were 6 specimens of *T. taphozous* or a form very near to it, in which the plates were more distinct. This relates *Taphozous* to *T. philipi* Wom. 1952, but the two can be distinguished on details of the scutum and the palpal setae, as shown in the Key later.
TROMBICULID MITES FROM MALAYAN BATS

TABLE 4

Standard Measurements of 8 Topotypes of Trombicula taphozous
Womersley, 1952

<table>
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<tr>
<th>No.</th>
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<td>37</td>
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Means Hołytype: 64.4 87.0 19.6 33.6 14 39.2 20 40 50 49.9 61.8

KEY TO SPECIES OF Trombicula ON BATS, ORIENTAL AND AUSTRALASIAN REGIONS

Myotrombicula is included in this Key because a specimen with the chelicerae missing may cause confusion. So that details of the palpal setae may be seen at a glance, they are when convenient shown as a palpal formula which the writer has found very useful as an aid to memory. The letters B (branched or barbed), b (with inconspicuous barbs or ciliations), and N (nude) are used to describe setae in the following order on the palps: femur/genu/dorsal-lateral-ventral setae on the tibia. The palpal formula for the akamushi-group is thus N/N/BNN, in which only the dorsal tibial seta is barbed.

In the section on Chaetotaxy, it will be seen that on the characters of the leg-setae T. balui is distinct from the others, while insollii and reveilei share characters which separate them from taphozous, harrisonii and dimolinae.

1. Chelicerae and palpi short, stout, modified (apparently for grasping hair); scutum a shallow rectangle, AW:AP = 63:16; apparently without eyes. From a bat, Australia. Myotrombicula vespertilios Wom. Not so ...................................................... 2.

2. Very small mite; scutum small, almost quadrato, AW:AP = ca. 49:25; sensillae bifurcate, without barbs, bases about central (ASB approx. = PFB = 20); DS short (29a); palp B/B(h)/NNN, claw 2-pronged. From Eumyotus, Taphozous, Malaya ................. T. balui Philip & Traub. Not so .......................................................... 3.

MUS. 24, 1952. [145]
3. Scutum trapezoidal, SB very close to posterior margin or in line of PLs; sensillae not thickened medially; all palpal setae N ........................................ 4.
   Scutum trapezoidal or almost rectangular; SB more centrally placed; palpal setae B/B/— or b/b/— .................. 7.
4. Scutum relatively deep, AP nearly equal to AW ............. 5.
   Scutum shallower, AP about half AW ............. 6.
5. Scutum larger and deeper, AW:AP = 60:42-57μ; AM longer than AL (ca. 52:32μ), with bases nearly in line and close to anterior border; posterior margin convex (?). From *Hipposideros*, Philippines ............ *T. piercei* Ewing.
   Scutum smaller, AW:AP = 50:35μ; AL and AM subequal (42:45μ); with AM base slightly in advance of AL bases, all distinctly behind anterior margin. From *Eonycteris*, *Taphozous*, Malaya .............. *T. insulli* Ph. & Traub.
6. Scutum posteriorly broadened with evenly convex posterior margin (AW:PW = 59:84μ); SB near line of PLs but ASE:PSB = 21:17μ; galeal seta B; palp B/B/NNB; DS 26, in rows 2.8.6.6.4.2. From bats, rats, marsupials, Australia and 'Solomons .......... *T. quadriensis* Wom.
   = *T. chiroptera* Wom.
   Scutum more nearly rectangular; SBs close to posterior margin which is shallow and sinuous, ASE:PSB = 28:9μ; galeal seta N; DS ca. 50 in irregular rows 2.12.14.10, etc. From *Hipposideros*, Malaya .......... *T. revulca* sp. n.
   Scutum trapezoidal, AM less than 45μ, PL less than 50μ .... 8.
8. AW:AP less than 50:40μ; PW less than 65μ; sensillae peculiar, thickened medially .................................... 9.
   Scutum larger, AW:AP = 55-65: 24-37μ; PW about 80μ; anterior margin extended in front of AL—AM bases, with pair of small plates near anterior margin (may be difficult to detect in *Taphozous*); sensillae normal .......... 10.
9. Scutal margins relatively straight, posterior margin slightly concave medially, approaching SB (PSB 14μ); AM and AL bases almost in line on anterior edge of scutum; sensillae thickened medially with basal quarter of shaft smooth; DS
TROMBICULID MITES FROM MALAYAN BATS

less than 36, in regular rows 2.6.6.6, etc.; one pair sternal setae between coxae III; palpal B/B/BB, claw 3-pronged. From *Hippodiserus*, Malaya .......... *T. harrisoni* Wom.

Lateral acutal margins concave, anterior and posterior margins sinuous and broadly convex (FSB 16μ); AM bases slightly behind AL bases and not so close to the sinuous anterior margin; sensilla markedly thickened medially, bifurcate, with fairly long simple and bifurcate barbs, and proximal third of shaft spicate (only one sensilla seen); DS over 40, in irregular rows, 2.14.16.6 etc.; two pairs sternal setae between coxae III; palpal B/B/BB, claw 2-pronged. From *Rhinolophus*, Malaya ... *T. dimolicae* sp. n.

10. Scutum broad trapezoidal, PW:AW:AP = 87:64:39μ; lateral margin straight, posterior margin sinuous, acutely concave immediately medial to the PLs; ASB:PSB = 34:14μ; plates near anterior margin not regularly developed and may be indistinct, lying anterior to line of ALs; AL and AM subequal; sensilla with many barbs; setae on palpal femur and genu stout with many small barbs or ciliation. From *Taphozous*, Malaya .......... *T. taphozous* Wom.

Scutum shallower, PW:AW:AP = 80:64:24μ; posterior margin evenly convex, ASB:PSB = 25:15μ; line across scutum in front of AM-AL bases, with pair of small plates immediately behind it, in line of or behind line of ALs; AL setae shorter than AM by 5μ; sensilla with only 2–3 barbs; setae on palpal femur and genu less stout, with long branches or barbs. From *Hippodiserus*, New Guinea ... *T. philippi* Wom.

### TABLE 5

*Standard Measurements of Species of Trombicula on Bats*

<table>
<thead>
<tr>
<th>Species</th>
<th>No.</th>
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<td>50.0</td>
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[147]
Schöningstia (Ascoschöningstia) lipoxena Womersley, 1952. Fig. 4
= Euschöingstia lipoxena (Womm.), after American authorities.

Described from 31 specimens from a horseshoe bat, Hipposideros sp. Including the original collection, 288 specimens of lipoxena have been found on 29 out of 300 horseshoe bats (Hipposideros spp.) from the forest reserves in Selangor, together with a larger number of T. harrisi. The following notes may be added to those already published.

Larvae large, engorged ones broad and tick-like in appearance but pallid, light brownish or pinkish, in colour, attached all over wings and body of host but especially on inner surface of the wing membranes. Body tending to broaden rapidly with engorgement. Eyes absent, represented by a whorl of cuticular striae. Legs: Leg I: microspur distal to base of spur on tarsus; more slender proximal and thicker distal tarsus with a long microtarsus posterior to base of the latter; 2 genualae in tandem, third genu posterior or ventroposterior, with exceptionally long microgenula. Leg II: microspur proximally in tandem with spur; 2 pointed tibialae in tandem; one genuala. Leg III: fairly long slender tibiala and genuala. Scutum (fig. 4): with posterior margin conspicuously indented, in old mounts the posterior and lateral margins may become very difficult to define. Body Setae characteristically arranged, the first row of DS starting well behind the scutum and the posterior rows rapidly becoming crowded together, confused with the caudal setae, and difficult to count. The caudal tuft of long setae (40-45 μ) may be conspicuous. The ventral setae, numbering about 10 anterior and lateral to the anus, are nearly as long as the dorsal setae but have longer barbs.

Schöningstia hippolites sp. n. Fig. 5, 6

A small mite in the beugalis-group, close to S. punctata Radford but distinguished by the narrower scutum and unisetose coxae.

Description of Larva.—Body oval, unengorged specimen 185 μ × 125 μ. Colour pallid. Eyes 2 + 2, small and laterally narrowed, on ocular plate (17 μ × 6 μ). Cuticular striae fine and close. Gnathosoma: Cheliceral base with scattered punctae; blade 30 μ long, narrowing rapidly near tip to small tricuspid cap. Galeal seta nude. Palp: femur with small tubercle at angle; all setae on femur, genu, and tibia nude; tarsus obscure in specimen. Claw obscured but apparently 2-pronged; with axial prong
slightly curved, 15\(\mu\)m, with shorter dorsal accessory prong. **Legs:** 1 7-jointed, II and III 6-jointed; fairly short with relatively stout joints, I-III 155\(\mu\)m, ca. 120\(\mu\)m, and ca. 150\(\mu\)m respectively. Coxae unisetae, setae with long barbs. **Leg I:** the spur is thick and short with a small microspur proximal and slightly posterior to its base, near the margin of the tarsus; 2 tibialae in tandem, proximal slender and pointed, distal thick and blunt with long microspur immediately posterior to its base; anterior and posterior genuaeae with long microgenulae. **Leg II:** microspur obscured, apparently small and proximal to and near to base of spur; thick blunt distal and pointed proximal tibialae in tandem; pointed genuaeae. **Leg III:** short genuaeae; a posteroventral seta on femur, nude or with a single inconspicuous barb, about as long as the genu. This seta may appear to be a femurala. Seutum
(fig. 6): large and deep, extending to third dow of DS in unengorged specimen; punctae close, extending to edges; anterior margin very slightly but evenly convex, almost straight; one anterior and two posterior pairs of setae all stout and close to edge of scutum, ALs slightly shorter and less stout than posterior setae and with fairly long barbs, longer than with posterior setae. Sensillae missing, presumably subelavate. The Standard Data of the unique holotype are as follows: AW 46, PW 56, SB 35, ASB 21, PSB 93, AP 41, AL 25, PL 34μ. Body setae stout with conspicuous basal rings and short barbs; in rows 2.4.1.4. 8.2.8.4.2. = 40 DS (28μ; numerals 30μ), the first rows 4.1.4 interrupted by the scutum, the asymmetrical seta being on the left side of the single specimen. Caudal setae 28, + 30 VS (17μ) more slender and with longer, pectinate barbs. Sternal setae 2+2, 28 and 20μ long.

Type Material.—A single specimen, No. 20,960, on a horse-shoe bat (R. 16,025) Hipposideros sp., from Bk. Lagong P.R., Kepong, Selangor, on 5th September, 1951. Taken together with 16 specimens of T. harriii and 4 of Eusuch. lipoxena. Holotype to be deposited in the British Museum (Natural History).

Remarks.—This species is very close to S. punctata Radford, from shrews and rodents in Manipur (India), Burma, and Ceylon, but differs in the narrower scutum (posterior setae close to the edge) and the unisetae coxa-III, which is 2- setose in punctata (and 4-setose in the closely related S. kumaonensis Wom.), and in the arrangement of body setae lateral to the scutum (2.4.4. in hipposideros and 2.2.2. in punctata). In punctata the scutum at the level of the PLs is some 7-10μ wider than FW (see Fig. 6). The tendency to lateral extension of the scutum beyond the PL setae, with angulation, observable in punctata, reaches its extreme development in S. brevis Radford.

Two undescribed species from Malaya are intermediate in scutal characters between bengalensis and hipposideros. One of these (No. 24,680) has the anus borne on a plate. The leg setae of these two species have been compared with those of punctata, hipposideros, and bengalensis (from Kashmir). They all have the microseta of tarsus I very small and well proximal to the spur, but the other microsetae fairly long. The unusual nude seta (sometimes with a single ciliation or barb) on femur III is short in bengalensis and the two undescribed species and may be mistaken for a femoralia; in punctata and hipposideros this seta is about twice as long.

[ 150 ]  

BULL. RAFFLES
Fig. 6. Scutum of Schöngestiella hipposideros sp.n.

Hannemanniia sp. nov. Womersley, in MS

This species has been described by Womersley (in MS) from 33 larvae on 9 fruit-bats, Cynopterus (Penthetor) lucasi, Bukit Lagong F.R., Kepong, Selangor. The only other Hannemanniia described from bats is Hannemanniia perplexa Brennan 1947 from Eptesicus in North America, but the Malayan species is very different from it, with a broad shallow scutum, the SBs posterior to the line of the PLs and very close to the posterior margin.

Notes on Chaetotaxy

The following notes concern some difficulties which have arisen while making comparative morphological studies of chiggers from our Malayan collection.

Mar. 24, 1952.
1. Specialised Leg Setae.—The nomenclature devised by Wharton (1948) and summarised in Wharton et al. (1951) has been used in this paper. Womersley (1952) criticises the use of the term ‘spur’ for the blunt sensory rod on tarsal I and II as this is certainly not a spur in the current entomological sense.

But a short simple term is necessary and in the present paper Wharton’s nomenclature has been used unchanged, with the observation that the tibia may carry a tibiala which has all the characters (thickening and bluntness) of the tarsal ‘spur’, so that it may be worth while renaming the spur a tarsala and the microspur a microtarsala before long continued usage establishes the specially redefined ‘spur’. A number of interesting differences are appearing in the leg chaetotaxy of related species and Wharton’s stimulus in this direction has clearly been necessary and valuable. But a comparative description of the specialised setae and their relationships is required in addition to a simple enumeration.

The use of the terms mastigensalal, etc. would seem to need redefining, as the whiplike setae usually to be found on leg III appear to be of two quite distinct kinds. The most familiar ones are the long outstanding setae, but these appear to be simple long nude setae and in some cases they carry traces of hairs or cilia near the base. The setae on leg III of T. batui and the shorter posterior femoralae in all members of the Schengastiella bengalensis group are examples of such setae, though these particular setae are not very long and whiplike. The other kind of seta is more specialised, is hollow, refractile, and probably always striated though the striae may be very difficult to detect on the finer setae. There is always a characteristic tubular appearance near the base of these setae, which range in form from the short stout blunt rods of tarsai I and II, through the more slender and often tapering setae on the tibia and genu, to long whiplike setae such as those on leg III of T. insoli and T. dimotinae. These setae are characteristically curved, often very much so, while the less-specialised nude setae tend to be straight and frequently outstanding. It would seem that the ‘mastifemoralae’ and ‘mastigensalae’ of say T. insoli are different structures from the mastifemoralae and mastigensalae of, say, T. batui or T. niteroi, and that it would therefore be misleading to assume that they are homologous. In the present paper, this difficulty has been met by describing the whiplike setae such as those of T. insoli as long, tapering femoralae and genualae, and not as mastifemoralae and mastigensalae. Also, the specialised femoral seta on
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S. hippocidros is not a true femorala if these terms (viz., tibia, genu, and femorala) are to be reserved as Wharton apparently intended them for the hollow striated refractile setae, which incidentally appear never to carry barbs.

The writer has examined six of the species of Trombicula discussed in this paper, and these fall into three groups on the characters of the leg setae alone, as follows:

Group 1. Leg I with 2 genuae and unusually long microgenuae (longer in revelae). Leg III with 2 fairly long genuae and 1 long telofemorala (longer in revelae) ... T. insollii, T. revelae.

In revelae, microspur II usually anterior to base of spur; proximal in insollii.

Group 2. Leg I with 3 genuae, shorter microgenuae. Leg III with 1 genua, no femoralae. All these setae getting longer in the order: ...... T. tapheous, T. harrisi, T. dimolane.

In harrisoni, tibiae II not in tandem, with anterior one long slender blunt-tipped, posterior much shorter and tapering; microspur I curved, talon-like; spur II about 1/3rd length of spur I. Other species with no unusual characters.

Group 3. Leg I with spur (15μ) shorter than spur II (15μ); 3 tibiae (not 2) and microtibia; 3 genuae but apparently no microgenuae. Leg II with microspur anterior and distal to base of spur (not proximal). Leg III setae not hollow refractile, mostly outstanding; 2 nude setae near subterminals and 1 other on tarsus; 2 on tibia; 2 on genu; 2 on telofemur; 1 on basifemur. T. batu.

2. Body Setae.—It is customary to count and record as dorsal and ventral setae those body-setae (often excepting the sternal setae) which lie on one surface or the other of the mounted specimen. Some authors have occasionally referred also to the postero-ventral or caudal setae. The dorsal body-setae continue round the posterior curve of the larva to end in the neighbourhood of the anus. The posterior folding of the mounted specimen cuts across these 'dorsal' setae in a completely artificial way and there is no anatomical justification for making a division between 'dorsum' and 'venter' there. The true ventral setae
lie grouped in front of the anus, with one or two para-anal pairs (or even rows) and sometimes a post-anal pair. These latter ventral setae lie alongside caudal and lateral setae which are part of the main body-setae of dorsal type. The true ventral setae usually differ from the dorsal and caudal setae, e.g. in being shorter and less freely or more delicately barbed. In the region lateral to and behind the anus, the caudal setae of dorsal type and the true ventral setae may be readily distinguished in many species, but in others they pass insensibly from one type to the other. In the latter case, one may reasonably if rather arbitrarily count one or two para-anal pairs or rows in with the ventral setae. The proportion of main body-setae of dorsal type which appear on the so-called ‘venter’ varies with the degree of engorgement of the larva.

These setae are of taxonomic importance and a complete description must include not only numbers and descriptions of the setae, but a comparison of the ventral and caudal setae, with a note as to whether they appear distinct or not. It is suggested that a useful standard form of description is that which has been used in the present paper, viz.:—Description of conventional dorsal setae (DS) with enumeration and size of DS and humeral setae + number of caudal setae (CS) + ventral setae (VS), enumeration, size, and whether or not they intergrade with the caudal setae. The sternal setae require description if there are more than 2 pairs or if they differ from the ventral setae or among themselves.

Host Relationships

The following records give some idea of the distribution of chiggers on bats collected in Malaya by the Scrub Typhus Research Unit. Many of these bats are brought to us in bulk in spirit by aboriginal collectors in the forests. I am grateful to my colleague Mr. J. L. Harrison for all the identifications. The very large genera Hipposideros and Rhinolophus have not yet been worked out in detail, which is why the species of type hosts in the present paper have been omitted.

It appears from these records that bats are not nearly so frequently infested by chiggers as are most other mammals, nor do the bat-chiggers appear to be particularly rich in species, in spite of the expectation of host-specificity and the undoubted richness of the order Chiroptera. This may probably be explained by the relatively slight direct contact which bats have with a
miliæna in which the non-parasitic stages of the mites can thrive and produce larvae to which the bats are readily accessible. Birds, on the other hand, have very close contact with their nests and frequently also with the ground, and they are much more freely infested with a variety of chiggers.

The following list summarises the results of examination of 682 bats in our Malayan collection:

**Pteropodidae** (76 examined):
43 *Cynopterus* sens. lat. (fruit bats) examined, with *Hannemannia* sp. (33 mites on 9 bats, all of which were identified as *C. lucasi*).

[*Eonycteris spelaea* (cave fruit bats) (Philip and Traub coll.) with *T. batui* (5) and *T. insolii* (3).]

The following 38 bats were uninfested by chiggers:
21 *Pteropus* (flying foxes), 3 *Rousettus* (rousettes), 3 *Balitycterius* (spotted-winged fruit bats), 3 *Macroglossus* (long-tongued fruit-bats).

**Emballonuridae** (54 examined):
15 *Emballonura* (sheath-tailed bats) with 1 *T.leveri* (originally from an *Emballonura* in Fiji).
39 *Taphozous* (tomb-bats) with *T. taphozous* (11 on 2 bats), *T. insolii* (30 on 2), *T. batui* (1), and *T. dehiscens* (1).

**Rhinolophidae** (382 examined):
7 *Rhinolophus* spp. (leaf-nosed bats) with *T. diminuens* (12 on 1).
361 *Hipposideros* spp. with *T. harrisi* (475 on 37) and *E. hypoxena* (288 on 29) plus 154 mites of these two species (in a pooled batch of 61 bats) also with 1 *S. hipposideros*; an additional batch of 14 *Hipposideros* sp. from a cave in Perlis with *T. taphozous* (6 on 4) and *T. revelae* (7 on 4).

**Vespertilionidae** (161 examined):
All uninfested:—99 *Myotis* (mouse-eared bats), 16 *Pipistrellus* (pipistrelles), 33 *Tylonycteris* (club-footed bats), 6 *Nyctalus* (noctules), 1 *Scotophilus*, 6 *Kerivoula* (forest bats).

**Molossidae**:
All of 9 bats uninfested:—1 *Cheiromeles* (hairless bat), 8 *Chaerephon* (wrinkle-lipped bat).

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The chiggers have been recorded from particular hosts as follows:

- **T. deliensis**: Recorded from every order of land mammals in Malaysia (except for the Edentates which have not been adequately examined).

- **T. batui**: Eonycteris spelaea, Batu Caves (limestone), Selangor; Taphozous melanopogon, cave (metamorphic rocks), Seletan Island, Selangor coast.

- **T. piercei**: Hipposideros diadema grisaeus, Barrio Buyog, Negros, Philippines.

- **T. insulari**: E. spelaea, with batui; Taphozous melanopogon, Seletan Island.

- **T. quadriens**: Unidentified bat and Chalinolobus gouldii

- **T. revelae**: Hipposideros sp., limestone cave, nr. Kangar, Perlis.

- **T. lever**: Emballonura spp., Fiji, and Forest Reserve, Kepong, Selangor.

- **T. harrisoni**: Hipposideros spp., forest fringe, etc.

- **T. dimotinae**: Rhinolophus sp., Forest Reserve, Kepong, Selangor.

- **T. taphozous**: Taphozous melanopogon and T. affinis, Seletan Island; Hipposideros sp., limestone cave nr. Kangar, Perlis.

- **T. philipi**: Hipposideros cervinus, Hollandia, Dutch New Guinea.

- **M. vespertilionis**: Unidentified bat, probably South Australia.

- **E. hypogea**: Hipposideros spp. from forests, Selangor, with harrisoni. Fairly common species.

- **S. hipposideros**: Hipposideros sp., Forest Reserve, Kepong, Selangor.

- **Hannemannia sp.**: Cynopterus (Penthetor) lucasi, Forest Reserve, Kepong.
Trombicula schmietsi (Oude, 1914) is also from the Oriental region, from a bat from Khandala, India (mountains between Bombay and Poona). Womersley describes this (after Oudemans): it is distinguished by having an almost pentagonal scutum, eyes 2+2 on an ocular plate, 42 DS and some 116 VS, and a peculiar small porous disc ventrally behind each coxa III. The palp formula is B/B/NNN, galeal N. The legs have no long nude setae. The scutum is about 60 µ wide and about 50 µ deep.

Other bat-chiggers from outside this region are recorded below for the sake of completeness, but owing to a local inaccessibility of some of the literature, this list is imperfect, though it is probably complete for the African species:

Trombicula minutissimum (Ouds.)

Hippodidros caffer, Durban, S. Africa.

T. natelensis Law.

Rhinolophus geoffroyi zuluensis, Noodaeborg, Natal, and Stierfontein Caves, Transvaal, S. Africa.

T. myotis Ewing

Myotis lucifugus, Mt. Katahdin, Me., and Pocono Lakes Preserve, Monroe Co., Pa., U.S.A.

T. eptesici Brennan 1947

Eptesicus fuscus pallidus, Hamilton, Montana, U.S.A.

T. mexicana Ew.

Bat, San Luis Potosi, Mexico.

T. fahrenholzi (Ouds.)

Miniopterus schreibersi, Bremen, Europe.

T. muscae (Ouds.)

Bat (?), Europe.

T. myops Vitzthum

Bat, Europe.

T. rusecum (Ouds.)

Bat, Europe.

Dolosia synotl Ouds.

Barbastella barbastellus, Bremen, Germany.

Tecomatlana sandovali Hoffman

A bat, Mexico.

Ascoschoengastia—aethiopica (Hirst)

A small grey bat, Acera, W. Africa; and Myotis goudoti, Madagascar.

Eusch. hamiltoni Brennan

Eptesicus fuscus fuscus, Millerton, New York; and Myotis subulatus leibii, Germantown, New York.

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*E. pipistrelli* Brennan

*Pipistrellus subflavus subflavus*, Mud Cave, Stone County, Missouri, U.S.A.

*Cakhrileps* *namus* (Ouds.)

*Hipposideros caffer*, Durban, S. Africa.

*Aconolacrus polydens* (Ouds.)

*H. caffer*, Durban, S. Africa.

*Hannomanaia perplexa Eptesicus fuscus pallidus*, Custer, Montana, U.S.A.

Brennan

There are in addition several species found as adults or larvae in caves, fairly often in bat-guano, and the larvae of these might be feeding on bats. Examples are *T. cavicola* Ew. (Reynold's Cave, Ky., U.S.A.), *T. cuverarum* Ew. (Panama), *T. camilla* Wharton (Oxolotl Caves, Yucatan), *T. moesica* Andre (Gradje Cave, Yugoslavia), *T. russica*, Vizithum (bat guano, cave near Trieste, Italy), and *Trisetica [T. eamata] melan* Traub and Evans (bat cave nr. Myitkyina, North Burma).

Summary

1. The trombiculid mites, infesting bats are of particular interest for several reasons, one of which is the occurrence of bats in Europe, North America, and probably Africa, of mites very closely related to *Trombicula akamushi*, the vector of scrub typhus in south-east Asia.

2. Two new species of *Trombicula*, and one of *Schöngastieella*, are described, and supplementary descriptions are given of six other species infesting bats in Malaya. A key to the species of *Trombicula* is presented.

3. A comparative study of the leg chaetotaxy has been made. The whiplike and other specialised setae on leg III may be of two distinct kinds and these should be differentiated. A more realistic description of the dorsal and ventral body-setae is recommended.

4. Lists are presented as the results of examining 682 bats in Malaya, and also of the host-relationships of 15 species of trombiculids from the Oriental and Australasian regions, 6 from Europe, 5 from Africa, and 7 from the Americas. Six other species, suspected bat-chiggers, are recorded from caves.

[158] Bull. Raffles
References


